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Enhancing photovoltaic performance of P3HT/PDI donor-acceptor system via morphology control

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Semiconducting polymers and small molecules based organic solar cells (OSCs) offer a promising option for clean, renewable, and affordable energy sources. Over commercialized silicon solar cells, OSCs exhibit advantages of solution processibility to enable large-scale roll-to-roll fabrication, mechanical flexibility, potential low cost, and synthetic variety. In OSCs, the active layer that consists of two distinct components: An electron donor (D) and an electron acceptor (A), plays a critical role in determining the device efficiency. It is essential to control the morphology of the active layer where excitons are generated and dissociated into charge carriers that then migrate in opposite directions to the electrodes. Nevertheless, several challenges still remain to be addressed in order to make OSCs competitive compared to their inorganic counterparts.

To improve the progress of organic-based devices, synthetic methods need to be developed to make well-defined three-dimensional structures with a controlled size and shape in conjunction with delicately organized self-assembly properties. In this work, we report enhancing photovoltaic performances of poly (3-hexylthiophene) (P3HT) and perylenediimide (PDI) donor-acceptor system via controlling the structural morphology of the D-A dyads. Variuos shapes and sizes of donor P3HT and acceptor PDI nanostructures were prepared by base-catalyzed condensation of their respective alkoxysilane precursors and evaluated their device performance. Through morphology control, we were able to enhance the device performance of P3HT/PDI system up to the power conversion efficiency (PCE) of 2.6%. The future work will focus optimizing the aspect ratio of nanostructures and device architecture to improve PCE of this D-A dyad.

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